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TITLE: DFT-based Spectral Moment Estimators for spaceborne Doppler precipitation radar

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BRIEF BIOGRAPHY: Simone Tanelli is Research Associate in the Atmospheric Radar Science and Engineering Group at JPL. He received the "Laurea" degree (M.Sc., 1995) in electronic engineering, and the Ph.D. (1998) in "Methods and technologies for environmental monitoring" from the University of Florence. His main research interests are in the field of active remote sensing of the atmosphere.

ABSTRACT:

In this paper an in-depth analysis on the performance of the Fourier analysis in estimating the first spectral moment of Doppler spectra of rain signals from a spaceborne radar is presented. The spectral moment estimators based on the Fourier analysis (DFT-SME) have been widely used in the field of Doppler weather radar in measuring rainfall velocity and they have been found to be almost optimal for small normalized spectral widths (w_N). They are also more computationally efficient than the Maximum Likelihood estimators. However, the existing analytical approaches for evaluating the DFT-SME performance have mostly been focused on a limited range of small w_N (e.g., $w_N < 0.1$) that are typical of ground based and airborne Doppler weather radars. With the rapid advances in spaceborne radar technologies, the flying of a Doppler precipitation radar in space to acquire global data sets of vertical rainfall velocity has become a real possibility. The objective of this work is to develop a generalized analytical approach such that it can be extended to larger values of w_N (e.g., $w_N \sim 0.2$) in spaceborne radar applications. In particular, a method has been developed to properly treat the aliasing effects, which have become a significant error source in spaceborne remote sensing. Furthermore, several versions of DFT-SME (differing on the adopted strategies for noise handling and choice of the first guess of the mean Doppler velocity) have been analyzed with this generalized approach. The analytical results are in excellent agreement with those obtained through simulation. Such encouraging results suggest that the proposed approach is a reliable technique for fast and accurate prediction of DFT-SME performance for a variety of spaceborne radar system parameters.

Keywords: Doppler, Precipitation, Spectral Estimation, Spaceborne Radar, Fourier Analysis